REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)* 14-08-2015	**2. REPORT TYPE** Publication	**3. DATES COVERED** *(From - To)*
4. TITLE AND SUBTITLE Inflatable Launch and Recovery System		**5a. CONTRACT NUMBER**
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) Scott D. Boyd et al		**5d. PROJECT NUMBER**
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Undersea Warfare Center Division, Newport 1176 Howell Street, Bldg 102T, Code 00L Newport, RI 02841		**8. PERFORMING ORGANIZATION REPORT NUMBER** 102309
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Undersea Warfare Center Division, Newport 1176 Howell Street, Bldg 102T, Code 00L Newport, RI 02841		**10. SPONSOR/MONITOR'S ACRONYM(S)** NUWC
		11. SPONSOR/MONITOR'S REPORT NUMBER(S) 102309

12. DISTRIBUTION / AVAILABILITY STATEMENT

Distribution A

13. SUPPLEMENTARY NOTES

14. ABSTRACT

An inflatable launch and recovery system for a towed body is provided. The system is containerized for ease of transport. A container houses a tow body, tow cable, a winch, winch controls, an inflatable ramp, deployment and retrieval equipment, power junctions and air line connections. Inflatable arch shaped tubes and spacer fabric form the ramp structure from which the tow body can be launched and recovered. The ramp can be ballasted to provide hydrodynamic stability and to provide sufficient system depth to accommodate retrieval of towed bodies operating below a liquid medium surface. Additional control can be achieved using inflatable or rigid fin elements or downward lifting surfaces. A rigid clamping fixture connects the ramp structure to the vessel. A snubber element dampens vibrations and transient tow loads.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON** Annette M. Campbell
a. REPORT Unclassified	**b. ABSTRACT** Unclassified	**c. THIS PAGE** Unclassified	SAR	24	**19b. TELEPHONE NUMBER** *(include area code)* 401-832-4246

DEPARTMENT OF THE NAVY
OFFICE OF COUNSEL
NAVAL UNDERSEA WARFARE CENTER DIVISION
1176 HOWELL STREET NEWPORT RI 02841-1708

IN REPLY REFER TO

Attorney Docket No. 102309
14 August 15

The below identified patent application is available for licensing. Requests for information should be addressed to:

TECHNOLOGY PARTNERSHIP ENTERPRISE OFFICE
NAVAL UNDERSEA WARFARE CENTER
1176 HOWELL ST.
CODE 00T2, BLDG. 102T
NEWPORT, RI 02841

Serial Number	14/447,698
Filing Date	31 July 2014
Inventor	Scott D. Boyd

Address any questions concerning this matter to the Office of Technology Transfer at (401) 832-1511.

DISTRIBUTION STATEMENT
Approved for Public Release
Distribution is unlimited

INFLATABLE LAUNCH AND RECOVERY SYSTEM

[0001] This application claims the benefit of United States Provisional Patent Application Number 61/971,778; filed on March 28, 2014 by the inventor, Scott Boyd et al. and entitled "INFLATABLE LAUNCH AND RECOVERY SYSTEM".

STATEMENT OF GOVERNMENT INTEREST

[0002] The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

CROSS REFERENCE TO OTHER PATENT APPLICATIONS

[0003] None.

BACKGROUND OF THE INVENTION

(1) Field of the Invention

[0004] The present invention relates to launch and recovery systems, and more particularly a lightweight, containerized, inflatable launch and recovery system for towed bodies.

(2) Description of the Prior Art

[0005] Various at-sea training exercises require the launch, tracking and recovery of undersea vehicles. Due to the high costs of such vehicles; it is imperative that precautions be taken to ensure that the vehicles are not lost during exercises. Through the use of a towed body, these exercises can simulate the launch

and tracking of an undersea vehicle while enabling recovery of the vehicle at the conclusion of the exercise.

[0006] Launch and recovery systems for towed bodies used in undersea warfare exercises often require installations and infrastructures that are unique to the host vessel; especially when installed aboard research vessels. The specialized handling equipment used aboard research vessels lacks the adaptability required for their general use aboard multiple fleet platforms. The inability of the specialized handling equipment to readily support multiple platforms can limit fleet exercises. Furthermore, research vessels are typically unable to operate at fleet tactical speeds.

[0007] The systems in current use are generally vessel specific and rigid - often constructed of metal frames. These frames can take up considerable deck space that could otherwise be used for tactical operations. During exercises, the frames sometimes are subjected to overload events. As a result, the frames may permanently deform or fracture; thereby, rendering the frames inoperable.

[0008] What is therefore needed is a more flexible towed body launch and recovery system design that will enable deployment from a variety of fleet platforms. The system should be capable of operation at tactical speeds. Furthermore, a system is needed that provides a structurally fail-safe mode of operation during an overload event, i.e., an overload on the system should not cause major structural damage that shuts down the system.

[0009] There is also a need to minimize the deck space requirements of the launch and recovery system. In meeting these needs, the system should also reduce system installation costs and infrastructure requirements. Additionally, handling system weight, operational deployment times and retrieval times can also be reduced.

SUMMARY OF THE INVENTION

[0010] Accordingly, it is an object of the present invention to provide a towed body launch and recovery system that can be deployed from a variety of fleet platforms.

[0011] It is a further object of the present invention to provide a system capable of operation at tactical speeds.

[0012] It is a still further object of the present invention to provide a structurally fail-safe mode of operation in the event of an overload.

[0013] A still further object of the present invention is to minimize the deck space requirements of the towed body launch and recovery system. Additional objects are to provide a system that reduces system installation costs and infrastructure requirements.

[0014] In accordance with these and other objects made apparent hereinafter, an inflatable launch and recovery system for a towed body is provided. The launch and recovery system is lightweight and containerized for ease of transport and to provide a universal deck footprint. The system includes a standard shipping container that houses a tow body, tow cable, a winch and winch controls, an inflatable ramp, deployment and retrieval

equipment fittings, power junctions and air line connections. The system also includes power electronics and software controllers.

[0015] Multiple, inflatable, arch shaped tubes and spacer fabric form the ramp structure from which the tow body can be launched and recovered. Trailing end sections of the inflatable ramp can be ballasted to provide hydrodynamic stability against sea state motions and vessel wakes. The trailing end sections also provide sufficient system depth below the surface to accommodate retrieval of towed bodies operating below the surface. Additional control can be achieved using inflatable or rigid fin elements or downward lifting surfaces.

[0016] Connection of the leading inflated section to the vessel is provided by using a rigid clamping fixture with an optionally integrated dynamic snubber element to dampen out vibrations and transient tow loads. The main air fill line from the handling system to the inflatable ramp can be ported through the clamping fixture.

[0017] In one embodiment, the launch and recovery system includes a handling system for the towed body, an inflatable ramp and a container housing the towed body, the handling system and the inflatable ramp when the ramp is in a deflated configuration. The towed body is attached to the handling system when the ramp is in the deflated configuration. The ramp is inflated and extends from an aft end of the container and into a liquid medium in a deployed configuration. The towed body is detached from the handling system and positioned on the ramp when the ramp is in the deployed configuration.

[0018] In one embodiment, the ramp is comprised of at least two tubular longitudinal sections and a flat panel longitudinal section connected between the tubular longitudinal sections. The towed body is positioned on the flat panel longitudinal section when the ramp is in the deployed configuration.

[0019] The tubular longitudinal sections and the flat panel longitudinal section can each include a plurality of compartmented volumes. The ramp structure can also include a plurality of fill lines with each fill line connected between an air supply and one of the volumes. Each volume can include a pressure relief valve. The container can include air and electric connections to respective air supply and electrical systems of a vessel on which the container is located.

[0020] In one embodiment, the system includes a first winch positioned within the container and a cable connected between the first winch and an aft end of the ramp. The cable is wound on the first winch when the ramp is in the deflated configuration such that the aft end of the ramp is proximate to the first winch. The cable is unwound and extends away from the container when the ramp is in the deployed configuration such that the aft end of the ramp is distant from the first winch.

[0021] In one embodiment, the system includes a second winch positioned within the container and a cable connected between the second winch and a forward end of the towed body. This cable is wound on the second winch when the towed body is attached to the handling system such that the towed body is proximate to the second winch. The cable is unwound and extends away from the

container when the towed body is maneuvered down the ramp in the deployed configuration such that the towed body is distant from the second winch and the towed body is deployed into the liquid medium.

[0022] The system can also include a platform positioned within the container. A forward end of the ramp is connected to the platform. A snubber connection can be provided between the forward end of the ramp and the platform. The platform can be movably connected to the container using a series of sliding rails. The platform can be positioned at a forward end of the container when the ramp is in the deflated configuration. The platform can be positioned at the aft end of the container when the ramp is in the deployed configuration.

[0023] The second winch can be attached to the platform. The first winch also can be movably connected to the container. The first winch can be positioned at the forward end of the container when the ramp is in the deflated configuration. The first winch can be positioned at the aft end of the container when the ramp is in the deployed configuration.

[0024] In one embodiment, the system can include at least one ballast port in a trailing section of the ramp adjacent to the aft end of the ramp. The liquid medium can enter through the ballast port and into the ramp when the ramp is in the deployed configuration such that the aft end of the ramp is below a surface of the medium when in the deployed configuration. The aft end of the ramp can include a drain for the liquid medium from within the ramp. Additionally, the trailing section can include hydrodynamic

control elements, inflatable or rigid fin elements, or downward lifting surfaces.

[0025] In one embodiment, the launch and recovery system can include a standardized shipping container and an inflatable ramp disposed within the container in a stowed configuration when the ramp is in a deflated state. One standard ISO (International Organization for Standardization) shipping container has dimensions of 8 feet wide by 8 feet high by 20 feet long. Other sizes are commercially available. The ramp can extend from the container and into a liquid medium in a deployed configuration when the ramp is in an inflated state. The towed body is disposed within the container in the stowed configuration. The towed body is maneuverable from the container, along the ramp and into the liquid medium in the deployed configuration.

[0026] In one embodiment, the ramp is comprised of at least two tubular longitudinal sections having a plurality of compartmented volumes. A flat panel longitudinal section is connected between the tubular longitudinal sections and the flat panel longitudinal section also has a plurality of compartmented volumes. The towed body is positioned on the flat panel longitudinal section in the deployed configuration. The ramp further includes a plurality of fill lines. Each fill line is connected between an air supply and one of the compartmented volumes.

[0027] In one embodiment, the system includes at least one ballast port in a trailing section of the ramp. The liquid medium enters through the ballast port and into the ramp in the deployed

configuration such that an aft end of the ramp adjacent to the trailing section is below a surface of the medium in the deployed configuration. The aft end of the ramp also can include a drain for the liquid medium from within the ramp. Additionally, the trailing section can include hydrodynamic control elements, an inflatable or rigid fin elements, or downward lifting surfaces.

[0028] Other objects, features and advantages of the present invention including various novel details of construction and combinations of parts, will now be more particularly described with reference to the accompanying drawings and pointed out in the claims. It will be understood that the particular assembly embodying the invention is shown by way of illustration only and not as a limitation of the invention. The principles and features of this invention may be employed in various and numerous embodiments without departing from the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0029] Reference is made to the accompanying drawings in which are shown illustrative embodiments of the invention, from which its novel features and advantages will be apparent, wherein corresponding reference characters indicate corresponding parts throughout the several views of the drawings and wherein:

[0030] **FIG. 1** is a schematic and isometric view of an inflatable launch and recovery system of the present invention;

[0031] **FIG. 2** is a schematic cross-sectional view of the system of **FIG. 1**, taken in the direction of line **2-2** in **FIG. 1**;

[0032] **FIG. 3** is a schematic cross-sectional view of the system of **FIG. 1**, taken in the direction of line **3-3** in **FIG. 2**;

[0033] **FIG. 4** is a schematic isometric view of the system of **FIG. 1**, in a deployed configuration;

[0034] **FIG. 5** is an enlarged, schematic cross-sectional view of an area in **FIG. 3**, showing a ramp component of the system;

[0035] **FIG. 6** is an enlarged, end view showing self-draining ballast ports of the system taken in the direction of line **6-6** in **FIG. 4**; and

[0036] **FIG. 7** is a schematic of a downward and lifting body for the ramp component of the system.

DETAILED DESCRIPTION OF THE INVENTION

[0037] Referring now to **FIG. 1**, there is shown a schematic and isometric view of inflatable launch and recovery system **10** mounted on vessel **A** (only partially shown in the figure). Housing **12** of the system **10** is a standard shipping container secured to deck **B** of the vessel **A** with standard container cam locks **12a** (two of which are shown in phantom in **FIG. 1**). The system **10** can connect to a vessel power supply **C** via a power fitting **14**. Similarly, the system **10** can connect to a vessel air supply **D** via an air fitting **16**.

[0038] Referring also to **FIG. 2**, there is shown a cross-sectional view of the system **10**, taken along a plane in the direction of line **2-2** of **FIG. 1**. For clarity of illustration, but not limitation, cross-hatching and vessel **A** are not shown in **FIG. 2**. In the stowed configuration shown in **FIG. 2**, the housing **12**

encloses inflatable ramp **18**, a pair of top winches **20** (one of which is shown in **FIG. 2**), a lower winch **22**, a towed body **24** and a handling system **26**. The towed body **24** is supported by cradles **26a** of the handling system **26**. Typically, the housing **12** is mounted at aft end **E** of the vessel **A** (as shown in **FIG. 1**), such that the inflatable ramp **18** of the system **10** can trail behind the vessel **A** when the ramp is deployed.

[0039] In the stowed position, the ramp **18** is mostly deflated. Cabling **20a** from the top winch **20** connects to aft end **18a** of the ramp **18**. Rear section **18b** of the ramp **18** is supported above the handling system **26**. Mid-section **18c** of the ramp **18** drapes over shaped end **26b** of the handling system **26**. The shaped end **26b** allows the deflated ramp **18** to be drawn over the handling system **26** without damage to the ramp. Forward section **18d** extends along a lower inner surface **12b** of the container **12**.

[0040] Referring also to **FIG. 3**, there is shown a cross-sectional view of the system **10**, taken at reference line **3-3** of **FIG. 2**. For clarity of illustration, cross-hatching is not shown in **FIG. 3**. The top winches **20** are each mounted on one of a pair of top rails **28**, running longitudinally (as shown in **FIG. 2**) along upper inner surface **12c** of the container **12**. The cabling **20a** from each top winch **20** connects to the aft end **18a** of the ramp **18**. Platform **30** spans a pair of bottom rails **32**, with the rails running longitudinally (also as shown in **FIG. 2**) along the lower inner surface **12b** of the container **12**. Forward end **18e** of the ramp **18** is connected to the platform **30**. The lower winch **22** is mounted on the platform **30** between the rails **32**. Cabling **22a** of

the bottom winch **22** connects to forward end **24a** of the towed body **24**, which is supported by the cradle **26a**.

[0041] Referring also to **FIG. 4**, there is shown a schematic isometric view of the system **10**, with the system in a deployed configuration. During deployment, the top winches **20** and the platform **30** (together with the bottom winch **22**) move toward open doors **12d** along the respective top and bottom rails **28** and **32**. As a result, the ramp **18** passes through the open doors **12d** and extends from the housing **12** in a partially deployed configuration. Additionally, the handling system **26** moves the towed body **24** toward the open doors **12d** and lowers the towed body onto the ramp **18**.

[0042] For clarity of illustration, but not limitation, the top rail **28** and the bottom rail **32** are shown in **FIG. 2**, but not shown in **FIG. 4**. Also, the partially deployed configuration of the ramp **18′** is shown in phantom in **FIG. 2**, with the top winches **20′** and bottom winch **22′** shown in a position closer to the open door **12d′** and towed body **24′** shown lowered from the cradle **26a′** onto the ramp **18**.

[0043] As the cabling **20a** is unreeled from the top winches **20** and the ramp **18** is inflated; the rear section **18b** extends to a fully deployed position into ocean **F**. The rear section **18b** is ballasted so as to remain below surface **G** of ocean **F**, as shown in **FIG. 4**. (For clarity of illustration, but not limitation, surface **G** is denoted as wavy dotted lines against aft end **E** of vessel **A** and against the ramp **18.**) Additionally, ballasting provides hydrodynamic stability against sea state motions and vessel wakes.

Self-filling/drainage ballast ports **18f** are provided in the rear section **18b**. The rear section **18b** is configured to drain automatically through self-filling/draining ballast ports **18f** and the aft end self-draining ballast ports **18h** (See **FIG. 6** for detailed view of aft end ports). As described previously herein, forward end **18e** of the ramp **18** is secured to the platform **30.**

[0044] After the handling system **26** lowers the towed body **24** onto the ramp **18;** the cradle **26a** is removed (accordingly, not shown in **FIG. 4**). As the cabling **22a** is let off the bottom winch **22,** the towed body **24** begins descending down the ramp **18** (shown in phantom as **24′′** in **FIG. 4**), until the towed body is fully deployed into ocean **F.** The above-described process is reversed for retrieval of the towed body **24** and stowage of the ramp **18.**

[0045] Referring also to **FIG. 5**, there is shown an enlarged view of an area denoted as ellipse **5** in **FIG. 3. FIG. 5** shows a schematic cross-sectional view of the ramp **18.** For clarity of illustration, but not limitation, the bottom winch **22** is not shown in **FIG. 5** and only a portion of the platform **30** is shown. The ramp **18** is connected to the platform **30** by rigid clamping fixture **30a.** Dynamic snubber element **30b** can be integrated into the fixture **30a** to dampen out vibrations and transient tow loads. A dynamic snubber element is a mechanical element that operates in a similar fashion to a spring/dashpot system (i.e. a shock absorber). Depending on the construction, the dynamic snubber element dissipates kinetic energy through viscous or other forms of damping. The dynamic snubber minimizes undesirable motion

between structural components such that system motions remain within operational limits.

[0046] The ramp **18** includes two arched shaped tubes **34**, with flat panel **36** connected between the tubes. The tubes **34** can be fabricated of continuously circular braided material, reinforced with tensile webbing straps for shaping. As is known to those of skill in the art, tubes fabricated in this manner maintain their shapes when inflated. The panel **36** can be fabricated of woven spacer fabrics, also known as drop stitch fabrics. Such fabrics are known to those of skill in the art for use in inflatable boat decking.

[0047] For enhanced damage tolerance and puncture resistance; the skins of the drop stitch and tube fabrics would use dense woven architectures. For even greater damage tolerance and improved drop yarn strength; the use of crimp-imbalanced woven architectures are recommended in accordance with United States Patent No. 8,555,472 and the progeny of this referenced patent. The tubes **34** and panel **36** can be protected from environmental exposure through the use of a laminated elastomeric coating, in the manner known to those skilled in the art.

[0048] The tubes **34** and panel **36** can be fabricated in multiple sections, such as sections **18a**, **18b**, **18c**, **18d** and **18e** - as described with respect to **FIGS. 2**, **3** and **4**. Each section can be pressurized independently of other sections through manifolded fill lines **38**. Each section can include a fill port **40** connected to one of the fill lines **38**. Each section can also include a pressure relief valve **42**.

[0049] As shown in **FIG. 7,** a downward and lifting body **60** can be affixed to an underside of the ramp **18.** The downward and lifting body **60** can be a passive or active control surface to perform as ballast for the ramp **18.** As a passive control surface; the body **60** provides downward lift (a positive down depth) by allowing a flow **100** between the ramp **18** and the body. This flow or drag **100** assists in maintaining ballast on the rear section **18b**; thereby, keeping a significant portion of the ramp **18** beneath a ballast depth **H** and the surface **G.** This positioning allows a vehicle to easily position above or on the top of the ramp **18.**

[0050] The downward and lifting body **60** may also be controllable by allowing rotation **102** about an axis **62.** Control can be based on depth with the use of a pressure sensor (not shown) and/or by sensing velocity thru the surface **G.** Active control can compensate for the buoyancy of the ramp **18.** For a passive downward and lifting body **60;** there is no rotation about the axis **62.**

[0051] What has thus been described is a towed body launch and recovery system (**10**) having an inflatable ramp (**18**). The ramp (**18**) is lightweight and can be stowed in a standard shipping container (**12**) for ease of transport and to provide a universal deck footprint for the system. In addition to the ramp (**18**), the shipping container (**12**) houses the towed body (**24**), towed body handling system (**26**), tow cables (**20a** and **22a**), winches (**20** and **22**) and winch controls (not shown). Furthermore, the container (**12**) includes power junctions (**14**) and air line connections (**16**).

The system also includes power electronics and software controllers (not shown).

[0052] Multiple, inflatable, arch shaped tubes (**34**) and spacer fabric (**36**) form the ramp structure (**18**) from which the towed body (**24**) can be launched and recovered. Trailing end (rear) sections (**18b**) of the inflatable ramp (**18**) can be optionally ballasted to provide hydrodynamic stability against sea state motions and vessel wakes. The ballasted end sections (**18b**) also provide sufficient system depth below the surface to accommodate retrieval of towed bodies operating below the surface.

[0053] Connection of the forward inflated section (**18e**) to the vessel (**A**) can include a rigid clamping fixture (**30a**). The clamping fixture (**30a**) can include a dynamic snubber element (**30b**) that can dampen out vibrations and transient tow loads. The main air fill line **(38)** from the handling system **(26)** to the inflatable ramp (**18**) can be ported through the rigid clamping fixture (**30a**).

[0054] The foregoing description of the preferred embodiments of the invention has been presented for purposes of illustration and description only. It is not intended to be exhaustive or to limit the invention to the precise form disclosed; and obviously many modifications and variations are possible in light of the above teaching.

[0055] For example, space limitation within the container (housing) **12** can require power electronics and control software for the system **10** to be contained in one or more separate containers that can be connected between the vessel power supply **C** and the power fitting **14**. Furthermore, the system **10** can be

contained in any suitably sized structure other than a standard shipping container **12.**

[0056] As a further example, the inflatable ramp **18** can be constructed solely of spacer fabrics, cylindrical arches, cylindrical beams, or any mixture thereof using any flexible material that can maintain a shape when inflated and subjected to anticipated loads. The number and types of independent air volumes, manifolding, ballasting methods, pressure relief mechanisms, fill ports, etc., can also be varied extensively.

[0057] Also, rather than passively ballasting the ramp **18** through submersion of the trailing end section **18b**, the ballasting method can be actively controlled through the handling system **26.** Additional hydrodynamic control of the ramp **18** can be achieved using control elements **18g** located on the end section **18b** (one of which is shown in phantom in **FIG. 4**). As alternatives, elements **18g** can be fabricated as inflatable or rigid fin elements.

[0058] It will be understood that many additional changes in the details, materials, steps and arrangement of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention as expressed in the appended claims.

INFLATABLE LAUNCH AND RECOVERY SYSTEM

ABSTRACT OF THE DISCLOSURE

An inflatable launch and recovery system for a towed body is provided. The system is containerized for ease of transport. A container houses a tow body, tow cable, a winch, winch controls, an inflatable ramp, deployment and retrieval equipment, power junctions and air line connections. Inflatable arch shaped tubes and spacer fabric form the ramp structure from which the tow body can be launched and recovered. The ramp can be ballasted to provide hydrodynamic stability and to provide sufficient system depth to accommodate retrieval of towed bodies operating below a liquid medium surface. Additional control can be achieved using inflatable or rigid fin elements or downward lifting surfaces. A rigid clamping fixture connects the ramp structure to the vessel. A snubber element dampens vibrations and transient tow loads.

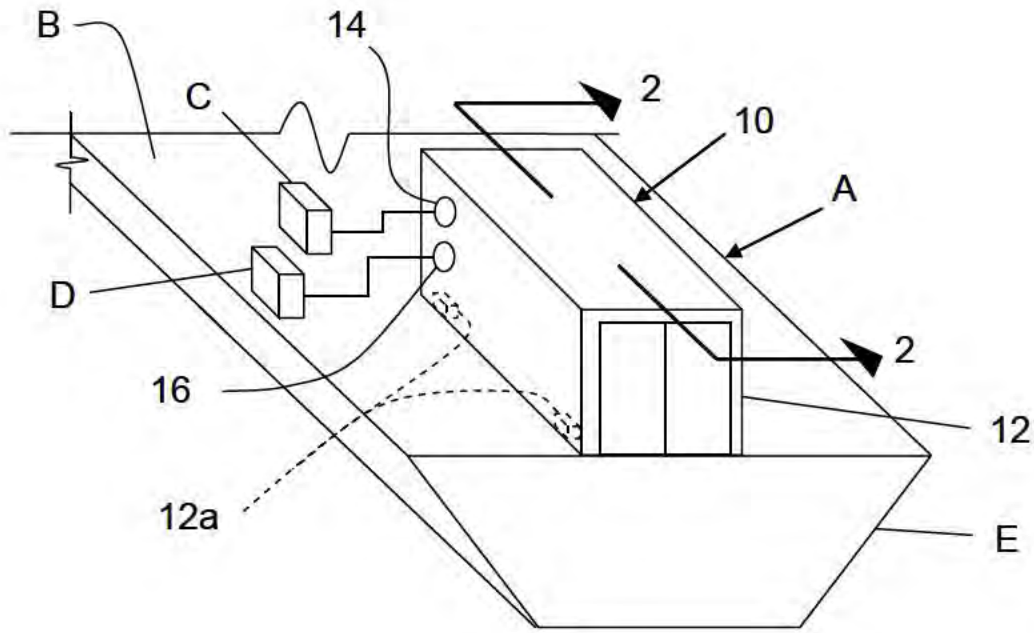

B
14
C
2
10
A
D
2
16
12
12a
E

FIG. 1

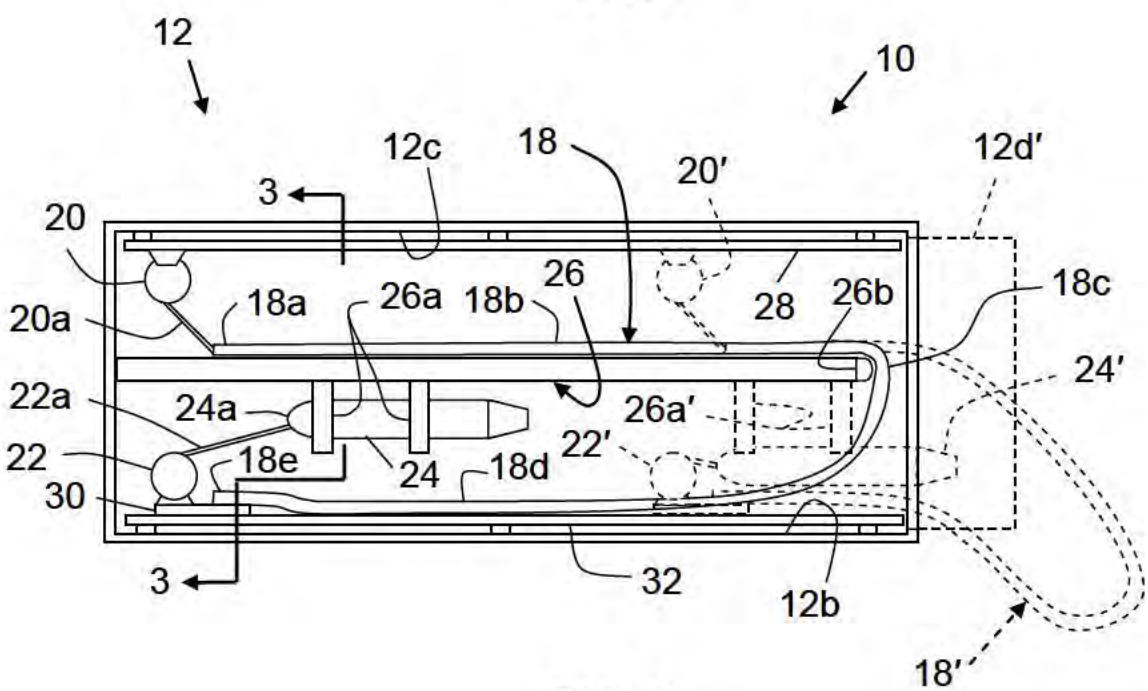

12
10
12c
18
12d′
3
20′
20
26
20a
18a
26a
18b
28
26b
18c
22a
24a
26a′
24′
22
18e
24
18d
22′
30
3
32
12b
18′

FIG. 2

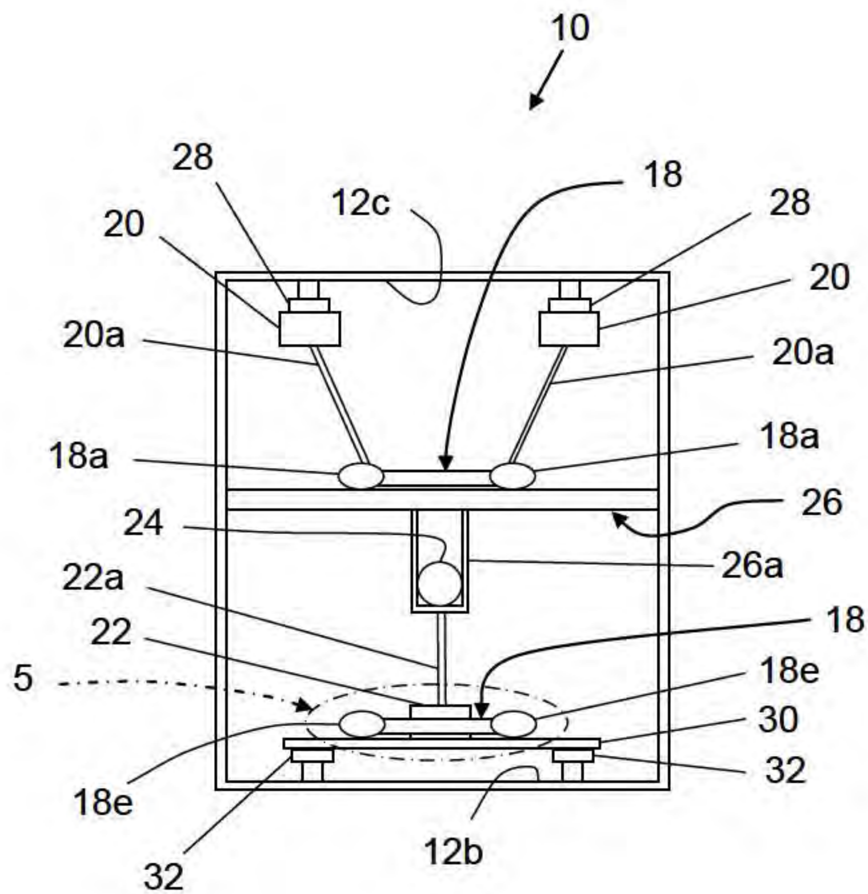

10
28
18
28
12c
20
20
20a
20a
18a
18a
26
24
26a
22a
18
22
18e
5
30
32
18e
12b
32

FIG. 3

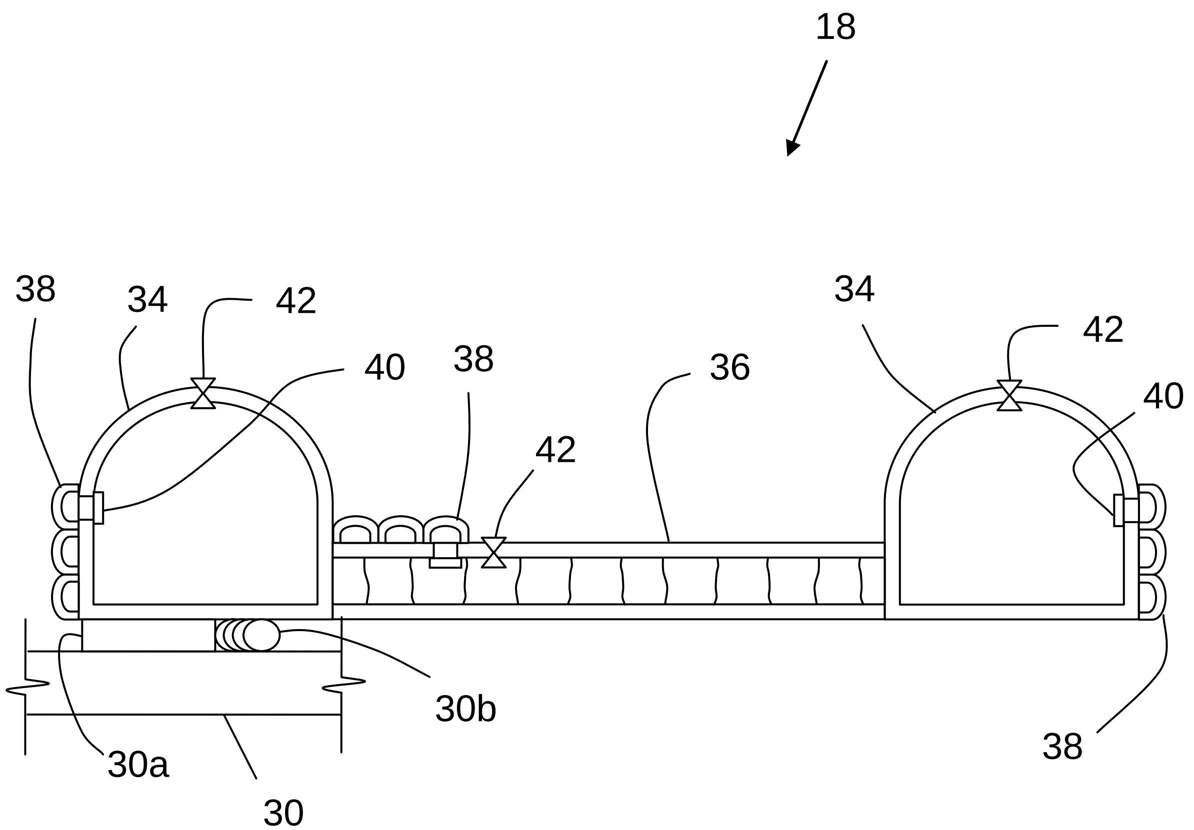
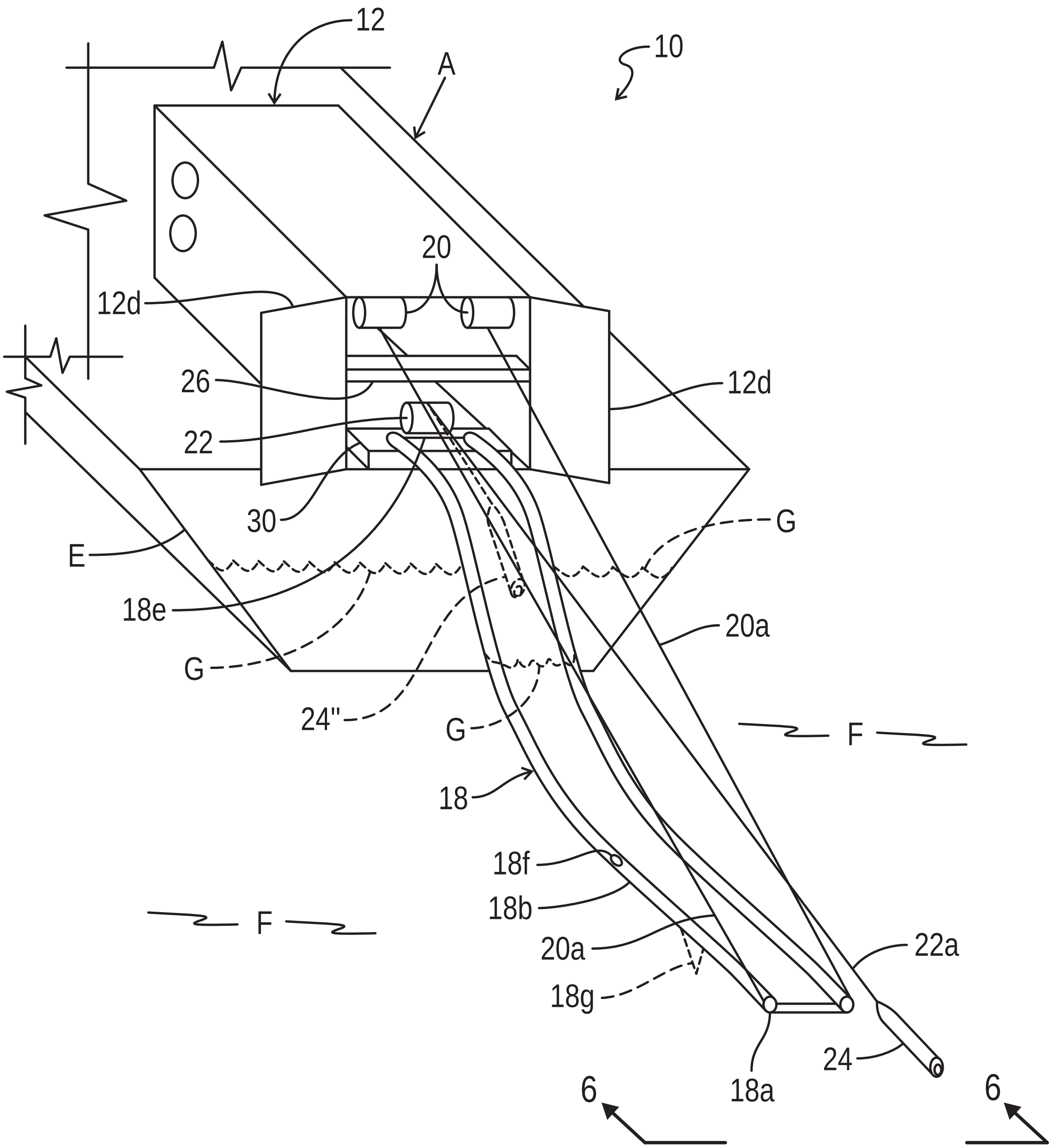


FIG. 5



12
10
A
20
12d
26
12d
22
30
G
E
18e
20a
G
24"
G
F
18
18f
18b
F
20a
22a
18g
24
6
18a
6

FIG. 4

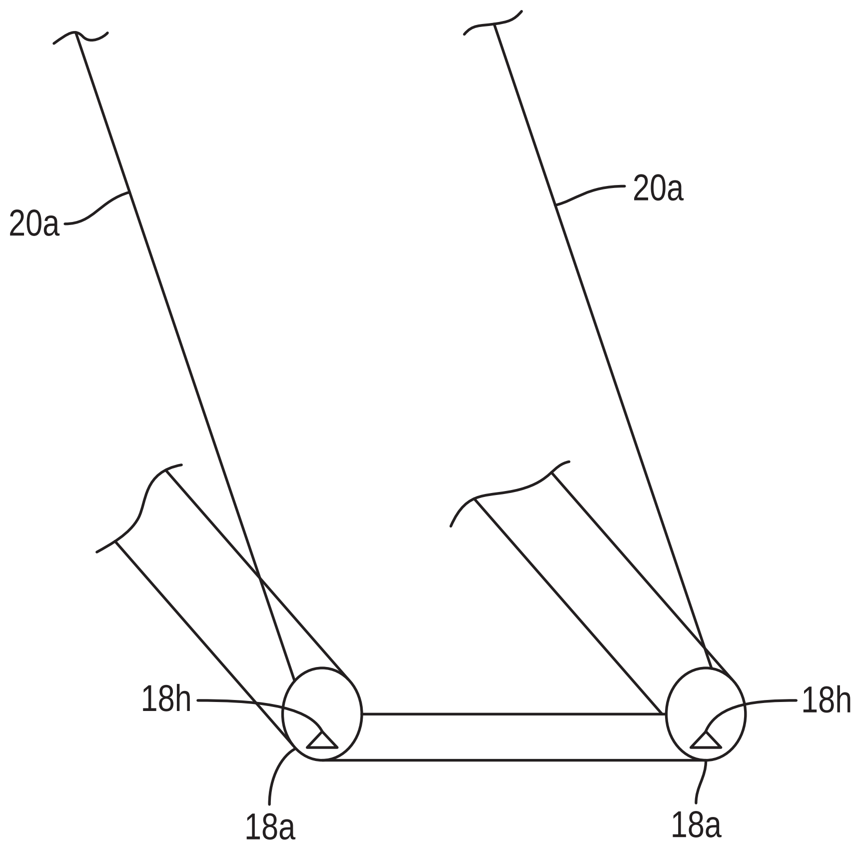


FIG. 6

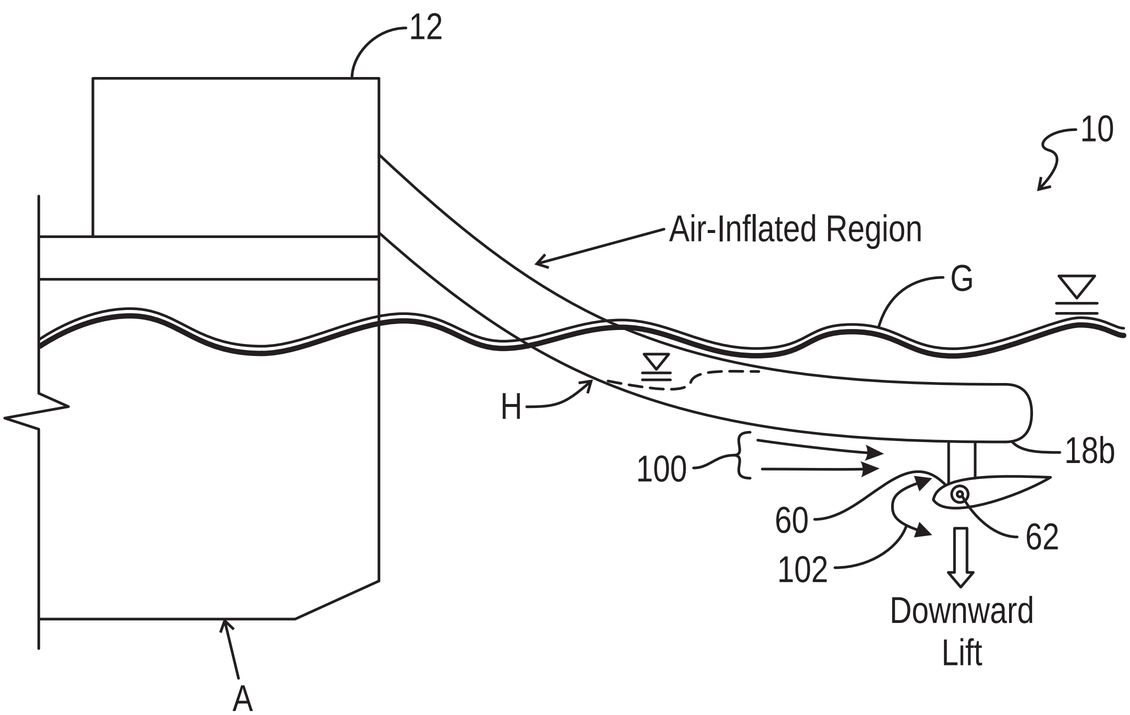


FIG. 7